U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.5.6 EMERGENCY DIESEL ENGINE STARTING SYSTEM

REVIEW RESPONSIBILITIES

Primary - Power Systems Branch (PSB)

Secondary - None

I. AREAS OF REVIEW

The PSB review of the emergency diesel engine starting system (EDESS) includes those system features necessary to assure reliable starting of the emergency diesel engine following a loss of offsite power to assure conformance with the requirements of General Design Criteria 2, 4, 5, and 17. The review includes the system air compressors, air dryers, air receivers, devices to crank the diesel engine, valves, piping up to the connection to the engine interface,[1] filters, and associated ancillary instrumentation and control systems.

1. The PSB reviews the EDESS to verify that:

   a. Each emergency diesel engine has reliable, redundant starting systems of adequate starting capacity.

   b. The system complies with appropriate seismic requirements and quality standards, and has been properly designed, fabricated, erected, and tested.

   c. Essential portions of the system are housed within seismic Category I structures capable of protecting the system from extreme natural phenomena, missiles, and the effects of pipe whip or jet impingement from high- and moderate-energy pipe breaks.

2. The PSB will determine the adequacy of design, installation, inspection and testing of all electrical components (sensing, control, and power) required for proper operation of the system, including interlocks.

[1] As defined by the engine manufacturer.

In the review of the diesel engine starting system, the PSB will coordinate the evaluations of other branches that interface with the overall review of the system as follows: The Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of structures housing the system to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5. The Mechanical Engineering Branch (MEB) determines that components, piping, and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3. The MEB also determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The Auxiliary Systems Branch (ASB) determines that the EDESS is in accordance with Branch Technical Positions ASB 3-1 and MEB 3-1 for breaks in high-energy and moderate-energy piping systems outside containment. The Materials Engineering Branch (MTEB) verifies, upon request, the compatibility of the materials of construction with service conditions. The Procedures and Test Review Branch determines the acceptability of the preoperational and startup tests as part of its primary review responsibility for SRP Section 14.0.

The reviews for fire protection, technical specifications, and quality assurance are coordinated and performed by the Chemical Engineering Branch, Licensing Guidance Branch, and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.

For those areas of review identified above as being part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding branch.

II. ACCEPTANCE CRITERIA

Acceptability of the diesel engine starting system, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria, regulatory guides, and industry standards. Information obtained from other Federal agencies and reports, military specifications, available technical literature, and operational performance data obtained from similarly designed systems at other plants having satisfactory operational experience will also be utilized to determine EDESS acceptability.

The design of the EDESS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 2, as related to the ability of structures housing the system to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR. Acceptance is based on meeting Position 13 to the appendix to Regulatory Guide 1.117, as related to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

2. General Design Criterion 4, with respect to structures housing the systems and the system itself being capable of withstanding the effects of externally and internally generated missiles, pipe whip, and jet impingement

forces associated with pipe breaks. Acceptance is based on meeting Position C.1 of Regulatory Guide 1.115 as related to the protection of structures, systems, and components important to safety from the effects of turbine missiles.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

4. General Design Criterion 17 as related to the capability of the diesel engine air starting system to meet independence and redundancy criteria. Specific criteria and guidance necessary to meet the relevant requirements of GDC 17 are as follows:

   a. Regulatory Guide 1.9 as related to the design of the diesel air starting systems.

   b. Branch Technical Position ICSB-17 (PSB) as related to diesel engine air starting systems' protective interlocks during accident conditions.

   c. NUREG/CR-0660 "Enhancement of Onsite Emergency Diesel Generator Reliability."

   d. IEEE Standard 387 as related to the design of the diesel engine air starting system.

   e. Diesel Engine Manufacturers Association (DEMA) Standard as related to the design of the diesel air starting system.

   f. Each diesel engine should be provided with a dedicated air starting system consisting of an air compressor, an air dryer, one or more air receiver(s), piping, injection lines and valves, and devices to crank the engine as recommended by the engine manufacturer.

   g. As a minimum, the air starting system should be capable of cranking a cold diesel engine five times without recharging the receiver(s). The air starting system capacity should be determined as follows: (1) each cranking cycle duration should be approximately 3 seconds; (2) consist of two to three engine revolutions; or (3) air start requirements per engine start provided by the engine manufacturer; whichever air start requirement is larger.

   h. Alarms should be provided which alert operating personnel if the air receiver pressure falls below the minimum allowable value.

   i. Provisions should be made for the periodic or automatic blowdown of accumulated moisture and foreign material in the air receiver(s), and other critical points of the system.

   j. Starting air should be dried to a dew point of not more than 50°F when installed in a normally controlled 70°F environment, otherwise the starting air dew point should be controlled to at least 10°F less than the lowest expected ambient temperature.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II of this SRP section. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the LGB review as indicated in subsection I of this SRP section. The reviewer will select and emphasize material from the paragraphs below, as may be appropriate for a particular case.

The primary reviewer will coordinate this review with the other branches' areas of review as stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SEB reviews the seismic design bases and the MEB reviews the quality and seismic classification as indicated in subsection I of this SRP section. The PSB assures that essential portions of the EDESS including the isolation valves separating essential and nonessential portions are classified Quality Group C and seismic Category I. Components and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic and quality classifications have been included and that the P&IDs indicate any points of change at the systems and/or systems component interfaces.

2. The reviewer establishes that the EDESS description and piping and instrumentation drawings (P&IDs) clearly delineate all modes of operation and include the means for monitoring, indicating, and controlling receiver air pressure as required by the engine starting service. The P&IDs are reviewed to determine that the receiver(s) has been provided with a pressure gauge, relief valve, drain valve, and automatic means of maintaining the receiver pressure within an allowable range, and suitable low pressure alarms. If there are piping interconnections between the dedicated air start systems, they are reviewed to verify that a failure in the interconnecting piping could not lead to the loss of starting of more than one diesel engine. The building layout drawings are examined to ascertain that sufficient space has been provided around the components to permit inspection. The reviewer verifies that the air starting system meets the specific criteria given in subsection II, item 4 of this SRP section.

3. The SAR is reviewed to assure that each diesel engine air start system has its own compressor and that the compressor capacity is adequate with respect to the air receiver capacities of the dedicated air starting system.

4. The reviewer verifies that the system has been designed to be operated and maintained in the event of adverse environmental conditions such as hurricanes, tornadoes, or floods, and is protected against the effects of internally or externally generated missiles.

5. The reviewer determines that the failure of nonseismic Category I systems, structures, or components located close to the EDESS will not preclude operation of the system.

6. The reviewer determines that measures have been taken in the design of the EDESS to preclude the fouling of the air start valve or filter with moisture and contaminants such as oil and rust carryover. An air dryer(s) should be installed upstream of the air receiver(s) for the removal of entrained moisture.

7. The reviewer determines that essential portions of the EDESS are protected from the effects of high- and moderate-energy line breaks. Layout drawings are reviewed to assure that no high- or moderate-energy piping systems are close to the system, or that protection from the effects of failure are provided. The means of providing such protection are discussed in Section 3.6 of the SAR and the procedures for reviewing this information are given in the corresponding SRP sections.

8. The SAR information, P&IDs, related system drawings, and failure modes and effects analyses are reviewed to assure that minimum requirements of the system will be met following design basis accidents, assuming a concurrent single active failure and loss of offsite power. The analyses presented in the SAR are reviewed to assure function of required components following postulated accidents. Utilizing the descriptions, related drawings, and analyses, the reviewer verifies that minimum system requirements are met for each degraded situation over the required time spans. For each case the design is considered acceptable if minimum system requirements are met.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that his review supports conclusions of the following type, to be included in the staff's safety evaluation report:

> The emergency diesel engine starting system (EDESS) includes an air compressor, air dryer(s), filters, valves, and all components and piping connecting to the engine interfaces necessary to assure that the system will be available and capable of starting the diesel engine following a loss of offsite power. The scope of review of the system for the _____ plant included layout drawings, flow diagrams, piping and instrumentation diagrams, and descriptive information for the emergency diesel engine starting system and supporting systems essential to its operation. The essential portions of the EDESS that are necessary for the safe shutdown of the reactor or necessary to mitigate the consequences of an accident are designed to seismic Category I and Quality Group C.
>
> The staff concludes that the design of the emergency diesel engine starting system is acceptable and meets the requirements of GDC 2, 4, 5, and 17. This conclusion is based on the following:
>
> 1. The applicant met the requirements of GDC 2, "Design Bases for Protection Against Natural Phenomena," with respect to the ability of structures housing the EDESS and the system itself

to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, and GDC 4, "Environmental and Missile Design Bases," with respect to structures housing the system and the system itself being capable of withstanding the effects of externally and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks. The EDESS is housed in a seismic Category I structure which provides protection from the effects of tornado, tornado missiles, turbine missiles, and floods. This meets the positions of Regulatory Guides 1.115, "Protection Against Low-Trajectory Turbine Missiles," Position C.1, and 1.117, "Tornado Design Classification," Appendix Position 13.

2. The applicant has met the requirements of GDC 5, "Sharing of Structures, Systems and Components," with respect to capability of shared systems and components important to safety to perform required safety functions. Each unit of the _____ plant has its own emergency diesel generators, whose EDESS is not shared between the diesel generators.

3. The applicant has met the requirements of GDC 17, "Electric Power Systems," with respect to the capability of the air starting system to meet independence and redundancy criteria. Each EDESS is independent and physically separated from the other system serving the redundant diesel generator. A single failure in any one of the systems will affect only the associated diesel generator. Each of the starting systems is capable of cranking a cold diesel engine five times without recharging the air receiver(s). This meets the positions of Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants." The applicant has also met the positions of Branch Technical Position ICSB-17(PSB), "Diesel Generator Protective Trip Circuit Bypasses," and NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability." The applicant has met the requirements of the following industry standards: IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," and Diesel Engine Manufacturers Association (DEMA) Standard.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREG.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

4. 10 CFR Part 50, Appendix A, General Design Criterion 17, "Electric Power Systems."

5. Regulatory Guide 1.9, "Selection, Design, and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants."

6. Regulatory Guide 1.68, "Initial Test Programs for Water Cooled Reactor Power Plants."

7. Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles."

8. Regulatory Guide 1.117, "Tornado Design Classification."

9. Branch Technical Position ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1.

10. Branch Technical Position MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to SRP Section 3.6.2.

11. Branch Technical Position ICSB-17 (PSB), "Diesel Generator Protective Trip Circuit Bypasses," attached to SRP Section 8.3.2, Appendix 8A.

12. IEEE Standard 387, "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations."

13. Diesel Engine Manufacturers Association (DEMA) Standard.

14. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability."